2.0 PROPOSED ACTION AND ALTERNATIVES

The Proposed Action assessed in this SWEA/S-II consists of the construction and operation of the following five site development projects at NREL's STM site at Golden, Colorado:

- The ESIF, a new research facility;
- Phase 2 of planned site infrastructure improvements (Phase 2 of Full Site Development);
- A new second access road;
- Expansion of the WHF; and
- Expansion of the Visitors Center.

Figure 2-1 illustrates the current STM site layout, and Figure 2-2 illustrates the seven development zones DOE has established on the STM site for the management of ongoing and future site land use and development. The development zones are also illustrated and described in Section 2 of the SWEA (DOE 2003). Figure 2-3 illustrates the approximate proposed locations on the STM site for the projects that would be implemented under the Proposed Action.

NREL's internal planning process for site buildout is a coordinated effort between NREL and DOE. As mission needs and research focus areas are identified, NREL's Laboratory Development Office facilitates annual and long-term planning efforts across the laboratory to make sure that all planning efforts are integrated with program goals. Campus planning and buildout activities are aligned with the annual budget planning process and are incorporated into NREL's One Year Plan and Ten Year Site Plan. Development of the Ten Year Site Plan is an ongoing iterative process that is coordinated with NREL's Infrastructure and Campus Development Office.

2.1 Energy Systems Integration Facility

Descriptive Overview

The ESIF would serve as a model for sustainable high-performance design. It would demonstrate the integration of high-performance building design and practices, showcase technology advances, and demonstrate to industry the applications of renewable and energy-efficient technologies for this type of facility. The ESIF would incorporate energy efficiency, environmental performance, and advanced controls using a "whole building" integrated design approach and would be required to comply with Energy Star standards. In support of DOE's goal to demonstrate energy-efficient buildings with a lower impact on the environment, the facility would be designed to merit at least a Leadership in Energy and Environmental Design (LEED) "Gold" rating from the U.S. Green Building Council, which would be the highest-certified facility of its type with a high-performance computing data center as a major part of the building.

At the ESIF, technical staff would research, engineer, design, test, and analyze components and systems for a broad range of renewable energy generation capabilities. The ESIF would house a state-of-the-art, high-performance computing and data center. It would also support improved and expanded capabilities in the modeling and simulation of renewable energy and energy-efficient technologies and their integration into the existing energy infrastructure.

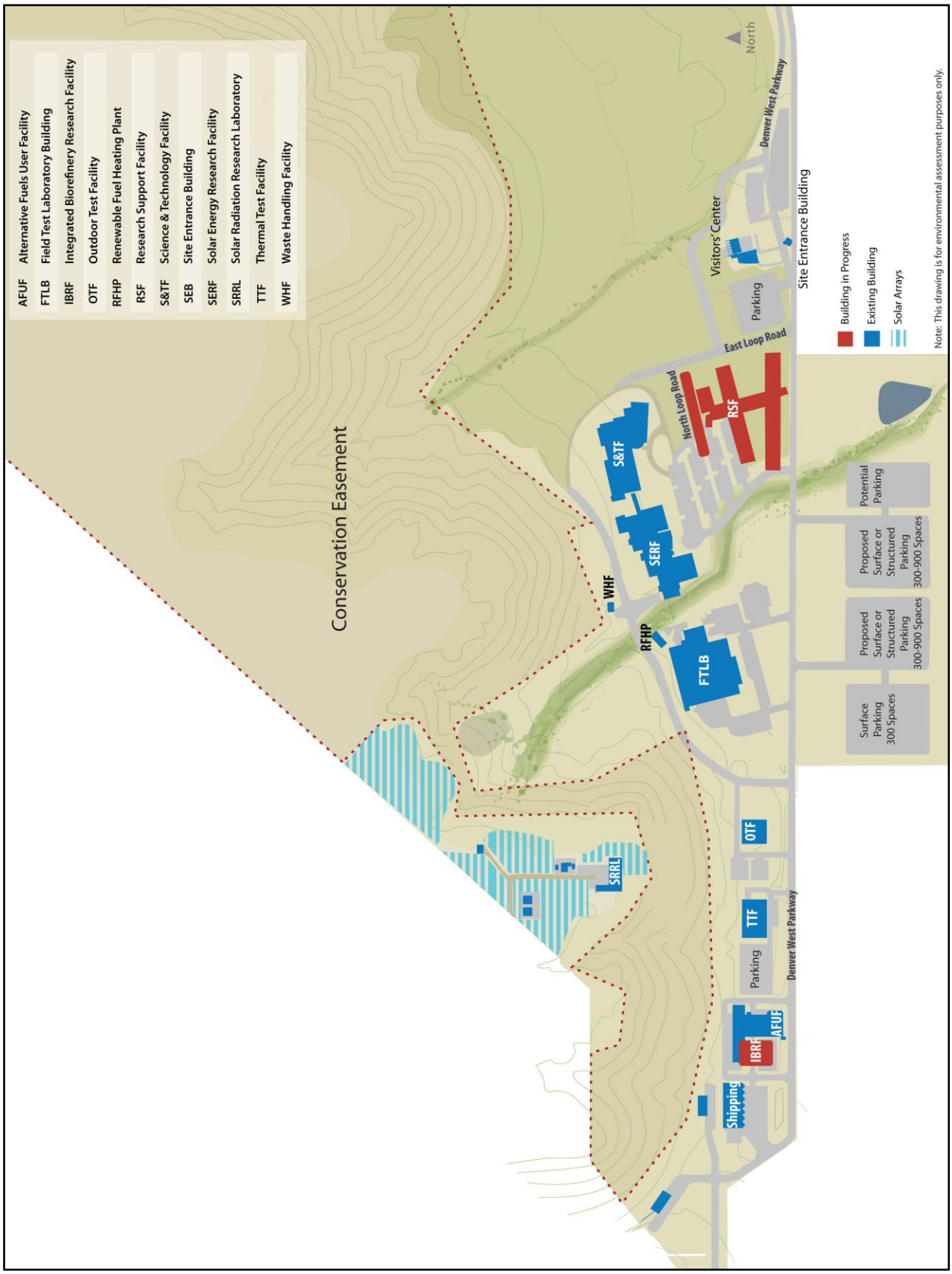

Figure 2-1. Current Site Layout

Figure 2-2. Site Development Zones

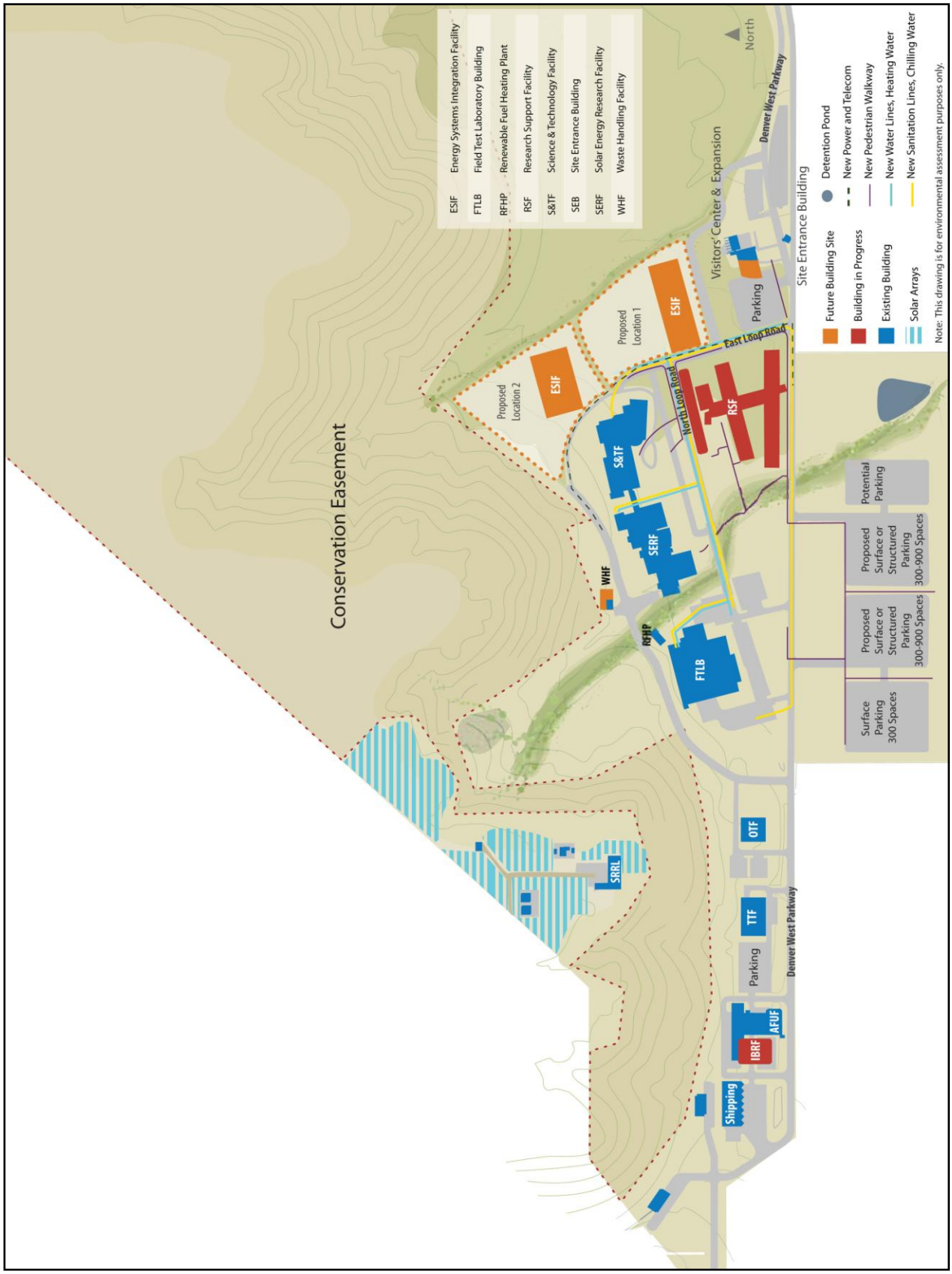

Figure 2-3. On-site Locations of Proposed Buildings and Upgrades

The ESIF would provide laboratory and research capabilities for:

- Solar technologies—interconnection, power electronics, building integration, and system optimization
- Buildings—sensors and controls, photovoltaic (PV) and other systems integration, modeling, and simulation
- Hydrogen—electrical interfaces, electrolyzers, storage, standards, fueling systems, fuel cell integration
- Wind—models, wind generation and grid interaction, grid analysis
- Vehicle technologies—hybrids and vehicle-to-grid integration, battery thermal management, power electronics
- Biofuels—gensets[1] and engines
- Energy storage—electrical and thermal

To support its research, the ESIF would house offices and shared areas to support a constant staff of approximately 250 personnel and would include special spaces such as conferencing capabilities, guest offices, and other "institutional" spaces that facilitate collaboration between NREL/DOE's private, academic, and public sector partners. In addition, outdoor pads would provide for testing larger equipment and systems up to a megawatt (MW) scale.

DOE anticipates the ESIF would have the following features:

- Approximately 20 to 30 laboratories and research areas of various sizes, each with different missions, construction requirements, and operational hazards.
- A high-performance computing and data center with sufficient room to support a minimum 100-Teraflop computer, all peripheral equipment, and enough space to allow for a future, redundant 1,000-Teraflop computer or even larger if appropriate.
- Approximately five outdoor and rooftop test pads that would be integrated with the building for testing and monitoring purposes.
- Research equipment and supporting infrastructure, including:
  - Electrical distribution test circuits
  - Electrical and grid simulators (wind turbine, PV, utility grid)
  - Hydrogen research equipment (fuel cell, dispenser, compressors, electrolyzers, storage)
  - Test pads and test cells (roof-mounted and ground-based PV, vehicle chamber)
  - Load banks and test busses (alternating current [AC], direct current [DC], motor load)
  - Other equipment (surge tester, electrical sources, dynamometer, metrology equipment, etc.)

[1] An engine-generator is the combination of an electrical generator and an engine mounted together to form a single piece of equipment. This combination is also called an engine-generator set or a gen-set. In many contexts, the engine is taken for granted and the combined unit is simply called a generator.

Physical Characteristics

The ESIF would be a one- to five-story building with a maximum footprint of approximately 23,230 square meters (250,000 square feet), plus an additional 1,850 to 2,800 square meters (20,000 to 30,000 square feet) of outdoor research test pads and associated infrastructure requirements (access road, services drives, etc.). A final decision on the number of stories that would be built would be based on the analyses provided in this document and ultimately on the input of a design-build contractor. The design may include Renewable Energy/Energy Efficiency technology such as roof-top PV. The approximate location of the proposed facility (to be located in STM Development Zone 4) is shown in Figure 2-3. Two alternative pad locations for the ESIF are proposed;~~.~~ a~~A~~ final decision on the building location would be based on the analysis provided in this document and ultimately on the input of a design-build contractor. Computer-generated simulations of the proposed new building are shown in Section 3.1.4 (Visual Quality/Aesthetics). Depending upon the outcome of this NEPA document and funding, construction could begin in 2010 and take approximately 18 to 24 months to complete. The maximum construction workforce is estimated to be approximately 100 to 150 workers.

ESIF construction would require a temporary laydown area of approximately 1.6 to 2 hectares (4 to 5 acres) and would be located east of the ESIF construction site on the east side of the east drainage. This area would be used to unload building materials, stage equipment, and park construction vehicles during the construction period. Access to the laydown area from the construction site would be provided by constructing a crossing over the east drainage. The crossing would consist of a culvert~~,~~ large enough to contain a 100-year flood, with fill and road base material placed over the culvert. Once construction is completed and the laydown area is no longer needed, the laydown area would be reclaimed and reseeded with an approved seed mix. The crossing over the east drainage may remain in place for further use in site buildout plans; however, when it is determined that the crossing is no longer needed, the road base, fill, and culvert would be removed and the topography of the area would be graded to preconstruction contours and reseeded using approved seed mix.

Major ESIF Programs

A Distributed Energy Resource Testing Program would be conducted that would use any energy source (such as a genset, hydrogen generator, natural gas microturbine, fuel cell, etc.) to model and test the switches that interconnect the energy source to the grid. The components of the Distributed Energy Resource Testing Program (Table 2-1) would mostly operate on outdoor test pads near the ESIF.

The Hydrogen Systems Laboratory (HSL) at the ESIF would be a comprehensive, flexible laboratory for testing equipment that produces and uses hydrogen. This laboratory would support the EERE's Hydrogen, Fuel Cells & Infrastructure Technologies Program, Wind & Hydropower Technologies Program, and Solar Energy Technologies Program, as well as supporting activities and research for other organizations. The HSL would be capable of evaluating and testing the hydrogen equipment, systems, and technologies of the future. It would provide space and resources for comprehensive testing and demonstration of hydrogen systems. The HSL would also include a nearby hydrogen systems outdoor test area for hydrogen storage, vehicle fueling stations, and large hydrogen systems equipment. The major testing activities of the HSL would include:

- Electrolysis of water to produce hydrogen using various electrolysis technologies
- Consumption of hydrogen in fuel cells to produce electricity
- Combustion of hydrogen in internal hydrogen combustion generators to produce electricity or to do mechanical work

Table 2-1. Distributed Energy Resource Testing Equipment

Generator Gensets	Capacity	Location	Operations	Fuel
Permanent Gensets				
Diesel genset 1	1 MW	Outside	24 hr/day, 2 wk continuous every 2 months (approx 12 wk/yr total)	Diesel biodiesel, hydrogen
Diesel genset 2	120 kW	Outside	24 hr/day, 2 wk continuous every 2 months (approx 12 wk/yr total)	Diesel biodiesel, hydrogen
Diesel genset 3	80 kW	Outside	24 hr/day, 2 wk continuous every 2 months (approx 12 wk/yr total)	Diesel biodiesel, hydrogen
Intermittent Gensets				
Diesel genset A	1 MW	Inside or outside	2 wk of continuous or intermittent operations per year	Diesel biodiesel, hydrogen
Diesel genset B	1 MW	Inside or outside	2 wk of continuous or intermittent operations per year	Diesel biodiesel, hydrogen
Diesel genset C	1 MW	Inside or outside	2 wk of continuous or intermittent operations per year	Diesel biodiesel, hydrogen
Facility Backup Power				
Diesel Genset	~500 kW, 3 MMBtu/hr	Outside	Expected at 12 hr/yr (monthly operational test)	Diesel

Note: hr = hour
kW = kilowatt
MMBtu = 1 million (1 thousand thousand) British thermal units
MW = megawatt
wk = week
yr = year

- Compression of hydrogen to high pressures (250 – 800 bar [3,500 – 12,000 pounds per square inch]) for storage or transport
- Delivery of vehicle fuel cell-grade hydrogen via hydrogen fuel dispensers for fuel cell vehicles
- Storage of hydrogen
- Investigation and development of hydrogen system design and sizing for hydrogen economy infrastructure

Hydrogen research program components that would be used for integrated renewable electrolysis system testing are listed in Table 2-2.

Summary of Principal Operational Hazards

Operations at the ESIF would present a variety of potential hazards that would be mitigated through a variety of controls. For example, testing and validation of methods and processes for the production, storage, processing, and distribution of hydrogen would be conducted. This work would include generating and compressing hydrogen on-site, fueling hydrogen vehicles, and testing equipment and fuel cells that use hydrogen as a fuel. The scale of this work would range from bench-top experimentation to end-use distribution systems, including 250-kilogram (kg) high-pressure storage tanks. Working with hydrogen presents risks associated with fire, explosion, or bursting of high-pressure vessels.

In addition, high-voltage surge testing of equipment would be conducted. This work would incorporate methods to create high-voltage arcs. This type of arcing can vaporize metal, ignite combustible materials, and result in serious injuries, fatalities, and property damage.

Testing and evaluation of several types of gensets and engine test chambers could also be performed in the ESIF. These engines would operate on a variety of fuel types, including biofuels and hydrogen. High-voltage load banks would be associated with this equipment. Potential hazards would include moving or rotating mechanical equipment, high temperatures, fire, and electrocution.

A detailed bounding events analysis for the ESIF is provided in Appendix C and is discussed in Section 3.1.3.

2.2 Site Infrastructure Improvements (Phase 2 Buildout)

The proposed Site Infrastructure Improvements (Phase 2 Buildout) would entail infrastructure improvements (roadways, parking structures, gathering areas, pedestrian/bicycle paths) and utility improvements in Zones 4, 5, and 6 that would service and support the proposed ESIF and other projected developments contemplated in the SWEA. Figure 2-3 illustrates the types and approximate locations of the proposed improvements. A new east-west roadway (referred to as the North Loop Road), connecting the East Loop Road and Denver West Parkway, and utility extensions would be part of this phase. Denver West Parkway through the campus would remain. As buildings are completed, the interconnectivity of pedestrian walkways, bicycle paths, and open space landscaping and gathering areas would also be completed. Site stormwater features and detention basins would also be improved as part of the Phase 2 Buildout. These improvements could consist of minor grading and recontouring, installation of drop structures, resizing of current detention basins, and installation of additional detention basins.

Table 2-2. Integrated Renewable Electrolysis System Components

Equipment	Size	Operating time	Operating pressure	Location	Noise	Fuel	Next step
Electrolyzer	One 1 MW or two 500 kW	24hr/wk (three working days)	200 psi	Indoors	Very quiet	1-MW cell will produce 200 kg hydrogen in about 12 hr	Compressors
Hydrogen Compressors (3)	6 ft wide x 4 ft long x 4 ft high	8 hr/day, 52 wk/yr, only while electrolyzer operating	3,500 psi 6,000 psi 12,000 psi	One indoors, two outdoors	Very quiet	Hydrogen sent to pressure tank storage	Storage tanks
Hydrogen Storage Tanks (12)	2.5 ft diameter by 20 ft long	8 hr/day, 52 wk/yr	5 tanks @3,500psi 1 tank @6,000psi 6 tanks @12,000psi	Outdoors	Silent	Approximately 200 kg of hydrogen weekly throughput from the electrolyzer via compressors	Combustion engine, fuel cells, turbine generator, fuel stations
Hydrogen Filling Station 1	Pump size approx 3-ft x 3-ft footprint	2 to 5 fill activities per day	5,000 psi output	Outdoors	Very quiet	Hydrogen from the 6,000 psi storage tank	Fleet of 5 to 10 cars, two buses, 2 to 5 fill activities per day
Hydrogen Filling Station 2	Pump size approx 3-ft x 3-ft footprint	2 to 5 fill activities per day	10,000 psi output	Outdoors	Very quiet	Hydrogen from the 12,0000 psi storage tank	Fleet of 5 to 10 cars, two buses, 2 to 5 fill activities per day

Table 2-2. Integrated Renewable Electrolysis System Components (continued)

Equipment	Size	Operating time	Operating pressure	Location	Noise	Fuel	Next step
Hydrogen-Fueled Internal Combustion Engine Generator	60 kW (200 kW possible)	4 hr/day, 5 day/wk, 52 wk/yr	100 psi	Outdoors	Similar to a large diesel truck	Consumes 20 kg H_2/hr	Electricity sent to the grid
Hydrogen-Fueled Turbine Generator	250 kW	4 hr/day, 5 day/wk, 52 wk/yr	100 psi	Outdoors	Noise: Approx 65 dBA at 33 ft	Consumes 5 kg H_2/hr	Electricity sent to the grid
Fuel Cell 1	1 MW	4 hr/day, 5 day/wk	100 psi	Outdoors	Silent	Consumes 70 kg H_2/hr	Electricity sent to the grid
Fuel Cell 2 & 3	Two 50 kW	4 hr/day, 5 day/wk	100 psi	Indoors	Silent	Consumes 3 kg H_2/hr	Electricity sent to the grid
Equipment Cooling (propylene glycol closed-loop system)	Fan 5 ft x 5 ft	Continuous operation during equipment operation	Not Applicable	Outdoors	Approx 95 dBA at 6 ft	None	Not Applicable

Note: dBA = A-weighted decibel
ft = feet
H_2 = hydrogen
hr = hour
kg = kilogram
kW = kilowatt
MW = megawatt
psi = pounds per square inch
wk = week
yr = year

North Loop Road

Approximately 370 meters (1,200 feet) of two-lane, 6-meter (20-foot) wide paved road would be constructed. It would run from the East Loop Road to the Denver West Parkway (see Figure 2-3). The total footprint of the proposed roads, including shoulders, would be approximately 0.2 hectare (0.6 acre).

New Parking Areas

The total permanent footprint of the new parking areas, including access roads, would be approximately 4 hectares (10 acres). This new parking may be added to areas adjacent to the Visitors Center and/or to the new parking lots identified in SWEA/S-I south of Denver West Parkway (Figure 2-3). Multi-level parking up to five stories above grade could be constructed over those parking lots to provide the additional parking space. The lower level of the multi-story parking could be partially below grade.

Utility Improvements

Approximately 1,200 meters (4,000 feet) of trenching would be needed for new underground water, hot and chill water distribution, sewer, power, and telecommunication lines. The new lines would support the ESIF and future site development (see Figure 2-3). Because most of the improvements would be underground, they would not result in permanent footprints.

Drainage and Stormwater Improvements

The final size, number, and location of drainage and stormwater improvements would be determined during design of the proposed ESIF, the proposed expansions of the Visitors Center and WHF, and the new parking areas.

Landscaping, Walkways, and Bike Paths

Open-space landscaping, pedestrian walkways, gathering spaces, bike paths, and other campus amenities would be constructed. The location and design of these features would be determined based on the final location of the proposed projects.

2.3 Second Access Road

Consistent with the needs identified in traffic surveys conducted in 2007 and 2008 (FHU 2008) and most recently in 2009 (Baseline 2009), a new second access road providing access to and from the STM site would be built to accommodate additional traffic associated with the Proposed Action. DOE and NREL are considering five corridors for the second access road (Figure 2-4). Either a single corridor (Corridor A or Corridor E) or a combination of corridors (Corridor B/C, B/D, or B/D/E) are evaluated for the final roadway alignment. The routes, access points, and lengths of the corridors are described below, assuming a driver is leaving the site:

- Corridor A would connect with the existing western entrance gate on the STM site and extend south on Quaker Street, connecting to South Golden Road, a distance of approximately 0.69 kilometer (0.43 mile).
- Corridor B/C would begin at the proposed on-site parking lots and extend south to connect with South Golden Road, a distance of approximately 0.49 kilometer (0.31 mile).

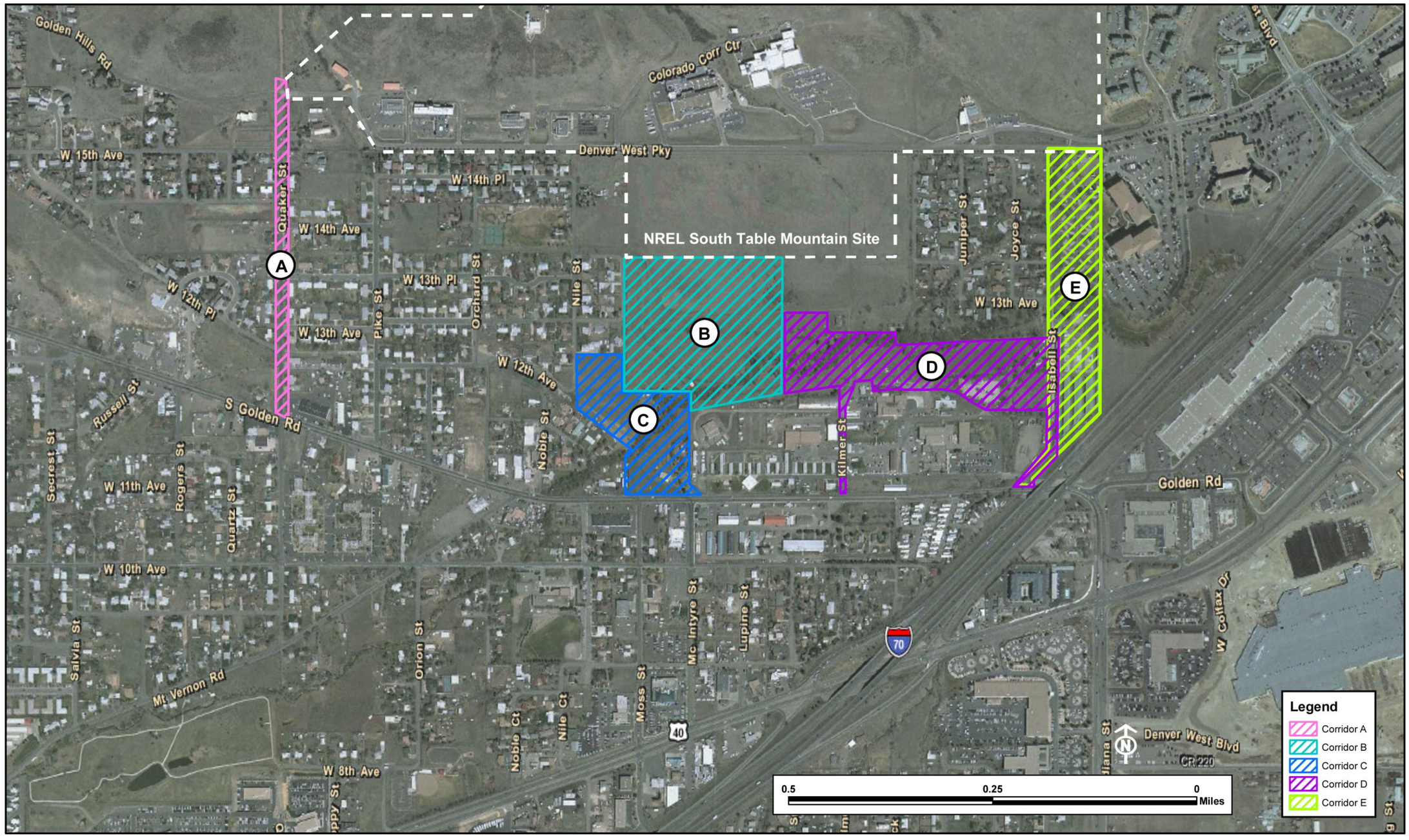

Figure 2-4. Proposed Five Corridors for the Second Access Road

- Corridor B/D would begin in the same area as Corridor B/C. From there, it would either utilize the existing access road (with upgrades) to the current parking lot for the Pleasant View Community Park or require new construction in an area nearby to cross Lena Gulch. It would then travel south on Kilmer Street to connect to South Golden Road. The total distance of this corridor would be approximately 0.88 kilometer (0.55 mile).
- Corridor B/D/E would be the same as the Corridor B/D option with the exception of using Isabell Street to gain access to South Golden Road. The total distance of this corridor would be approximately 1.13 kilometers (0.70 mile).
- Corridor E would begin at the Denver West Parkway near the current Visitors Center and travel south along Isabell Street to connect with South Golden Road, a distance of approximately 0.72 kilometer (0.45 mile).

For all of the proposed corridors, construction of either a new access road or widening and upgrades of existing roads would require a roadway right-of-way (ROW) width of 18.3 meters (60 feet). Additionally, a roadway on Corridors B, C, or D would require new bridging or a culvert over Lena Gulch, and Corridor E could require expansion of the existing bridge. Corridors A and E would require widening to sections of Quaker Street and Isabell Street, respectively, and Corridor D would require widening of Kilmer Street. The intersections of all corridors with South Golden Road would require either upgrades to existing intersection signals or new signals, and could require additional turn lanes and/or round-abouts. As a result, ROW expansions at these intersections could be required.

Preferred Corridor Alternative

Table- 2-3 summarizes the impacts that would result from constructing and operating a second access road to the STM site within each of the alternative corridors. These impacts are discussed in more detail in Section- 3.1. Based on this understanding of impacts, DOE has selected Corridor- B/C, (Figure- 2-5), as the preferred corridor for a second access road to the STM site. This corridor would provide the best traffic flow for employees to access the major arteries and freeways ~~streets~~; minimize the number of residential properties that might be affected; avoid large increases in traffic down existing residential streets; and avoid numerous historic resources and conflicts with other activities along Kilmer Street. Local, county and state traffic agencies support this corridor as the preferred corridor, as does the U.S. Army Corps of Engineers (USACE), which has jurisdiction over the wetlands and floodplains associated with crossing Lena Gulch, and JeffCo Open Space, which owns the land leased to the Pleasant View Park and Recreation District. The Colorado State Patrol and Colorado Department of Public Safety also concur that Corridor B/C would be the least disruptive to the state tenants of Camp George West.

Before a route could be sited within this corridor, DOE and NREL would negotiate a ROW with the current private and public land-owners; mitigate potential impacts to the Camp George West Historic District and historic resources to the satisfaction of the State Historic Preservation Officer (SHPO); work through the Clean Water Act Section- 404 permitting process with the USACE, which regulates the impacts to wetlands and floodplains and discharges to Lena Gulch that could result from a new crossing over Lena Gulch; and resolve the approach to intersection improvements at the South Golden Road/Moss St-reet intersection with Jefferson County. DOE would consider granting public access to the Pleasantview Park via any new routing but at this time would not consider linking a new access road to any of the existing residential streets to the west or east of Corridor B/C. DOE would also avoid construction over the existing natural gas pipeline.

Table 2-3. Second Access Road Comparison Matrix

Attribute	Corridor				
	A	B/C	B/D/Kilmer	B/D/E	E
New road required	N	Y	Y	Y	N
Upgrades and ROW expansion to existing off-site roads required	Y	N	Y	Y	Y
Private residences directly affected by ROW expansion	~15	0-3	0	0-2	10-12
Residential yards converted to ROW (acres)	1-2	1-2	0	0-1	1-2
Private residences experiencing new commuter traffic noise	~15	0-9	0-6	0-8	10-12
Conflicts with existing off-site businesses or uses	N	Y	Y	Y	Y
Camp George West Historic District affected by ROW expansion	N	Y	Y	Y	N
Historic resources potentially affected by ROW	0	0-4	11-15	0-4	0
Affected land ownership (percent)					
Private	100	50	-	25	100
County	-	50	75	50	-
State	-	-	25	25	-
Natural vegetation converted to ROW (acres)	0	2	3	3	0
Wetlands potentially affected (acres)	0	0.1-1	0.1-1	0.1-1	0.1
Floodplains potentially affected (acres)	0	0.1-2	0.1-3	0.1-3	0.1
Lena Gulch crossing (new or modified)	N	Y	Y	Y	Y
LOS AM at South Golden Road[a]	A	B	A	A	A
LOS PM at South Golden Road[a]	C	C	C	B	B
Percent increase in AM traffic[ab]	235	NA[bc]	514	412	412
Percent increase in PM traffic[ab]	166	NA[bc]	860	374	374
South Golden Road intersection improvement required	Y	Y	Y	Y	Y
Favorable traffic flow per DOT~~s~~	N	Y	N	N	N

a. LOS – level of service.
b. Traffic increases estimated along the affected roadway (e.g., Corridor A – Quaker St~~-~~reet, Corridor E – Isabell Street)
c. NA - not applicable, ~~since~~because there is no existing street within this corridor.

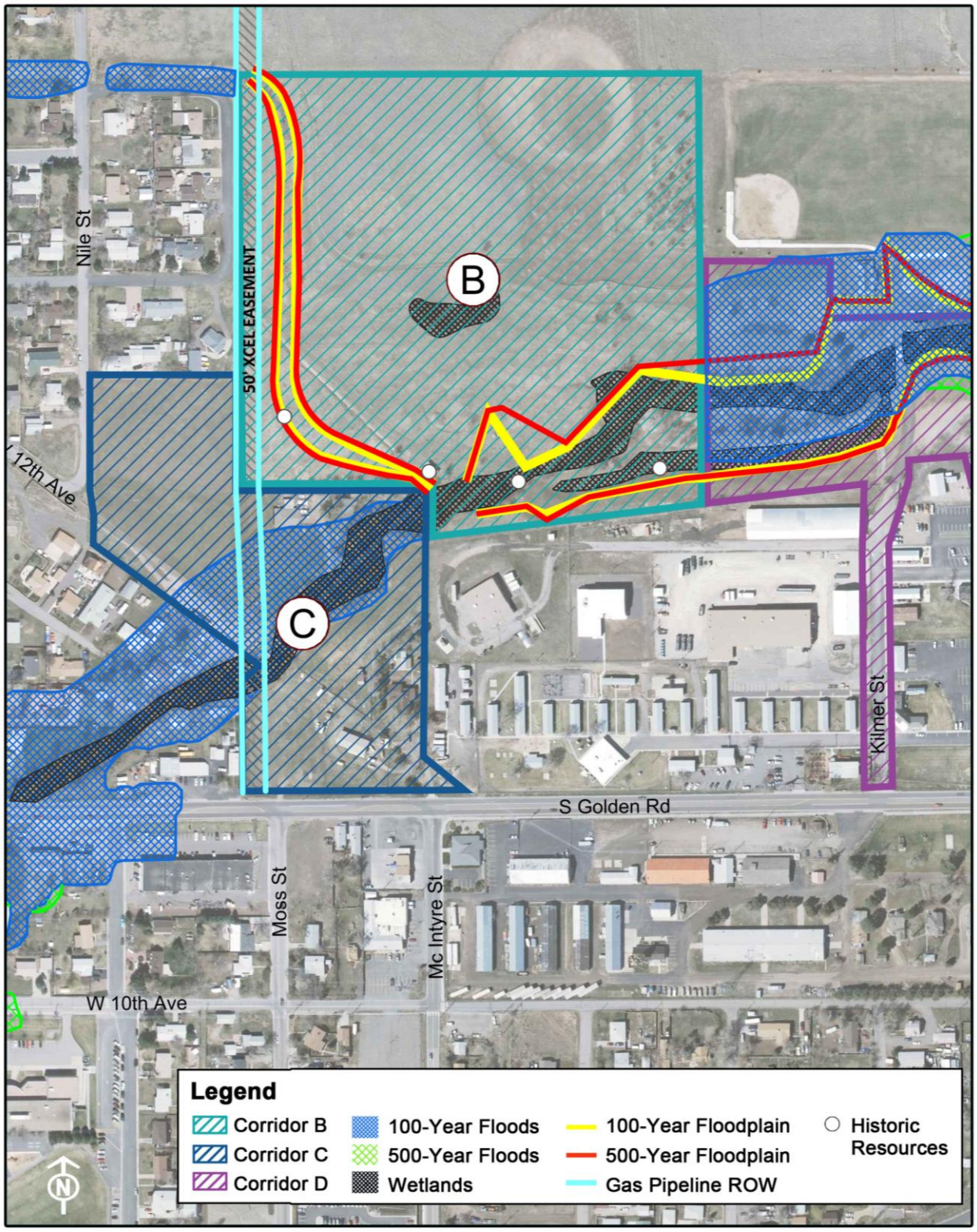

Figure 2-5. Close-up of Corridor ~~the~~ B/C ~~Corridor~~

2.4 Expansion of the Waste Handling Facility

The current WHF would be expanded from 99 square meters (1,065 square feet) to approximately 370 square meters (4,000 square feet). This expansion would accommodate anticipated future needs. The expanded facility would be used for packaging and short-term storage of NREL's increasing volume of hazardous wastes before the wastes are shipped off-site for disposal. No on-site waste treatment or disposal is proposed. The building would most likely be constructed of cinder block and concrete to match the existing architecture.

2.5 Expansion of the Visitors Center

The Visitors Center is currently about 600 square meters (6,500 square feet). DOE is proposing to approximately double the size of the center, to 1,200 square meters (13,000 square feet). The added space would include a large conference room and additional office and exhibit space. It could also include a café for visitor and employee use. The existing parking area may also be expanded to accommodate additional visitors.

2.6 No Action Alternative

The No Action Alternative would leave the site in its current configuration. The proposed ESIF construction, WHF and Visitors Center expansions, and new infrastructure projects, including a new second access road, would not be undertaken. However, the No Action Alternative would not preclude future projects addressed or contemplated in the SWEA from being proposed at which time DOE would make a NEPA determination.

2.7 Alternatives Considered But Not Analyzed

The Proposed Action and the No Action Alternative are the only alternatives specifically addressed in this ~~draft~~ SWEA/S-II. The Proposed Action alternative is to implement the five site development projects described in Sections 2.1 through 2.5. However, alternatives to the Proposed Action were raised and considered prior to the scoping period for the SWEA. The SWEA resulted in a finding that development in the central and south-central portions of the site, rather than other locations, was the most appropriate, technically feasible, and environmentally benign alternative. Other alternatives considered were eliminated from further analysis. The rationales for having eliminated these alternatives remain applicable to the current Proposed Action and are summarized below:

- New Site and Off-Site Improvements Alternative: not considered feasible because of the technical and cost implications associated with decentralized operations and site/infrastructure complications.
- Other Site Development Configuration Alternatives: not considered feasible because of the interrelated nature of the proposed facilities, site development constraints, and the inherent flexibility of the Proposed Action with respect to future facility footprints.
- Reduced Development Intensity Alternative: not considered feasible because it is inconsistent with the Proposed Action's purpose and need and the intent of preparing the SWEA and its supplements, which is to facilitate NREL in carrying out its mission.